Page Content

Types of bioretention

Information: The information on this page was updated in 2015 and placed on a new page. We recommend you use the information from the new page, which is called Bioretention terminology

As **bioretention** becomes a more common tool in the stormwater management toolbox and as the number of design variants increases, so does the number of names for each of these variants. As an example of the ongoing evolution of bioretention terminology, the terms “rain garden” and “rainwater garden” are used interchangeably with bioretention. In most instances, rain garden designs are utilizing the processes of bioretention, but the term rain garden is also being loosely used to describe **best management practices** (bmps) that are operating more as stormwater ponds (or as other BMPs) than as bioretention facilities.

Further confusion stems from the using the terms “process” and “practice” interchangeably. As mentioned earlier, bioretention is not a “practice” per se, but rather a process or group of processes that can be incorporated into many different practices. This section provides clarity the more common bioretention terminology being used in the field of stormwater management today.

Contents

Download pdf (https://stormwater.pca.state.mn.us/index.php?title=File:BMPs_for_stormwater_infiltration_-_Minnesota_Stormwater_Manual.pdf)

General discussion of types of bioretention BMPs

This section provides an overview of the general types of bioretention practices.

Bioinfiltration with no underdrain

This page provides general information

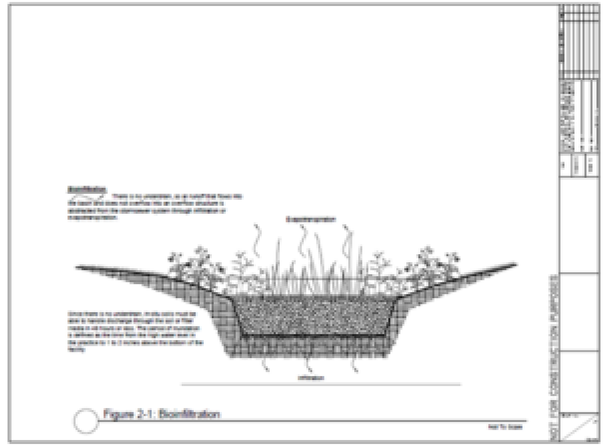
Bioinfiltration is suitable for areas where significant recharge of groundwater is possible and would be beneficial. Because there is no **underdrain** the in-situ soils need to have a high infiltration rate to accommodate the inflow levels. The **infiltration rate** of the in-situ soils must be determined through proper soil testing/diagnostics. The *Recommended* filter media (**engineered media**) (https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_bioretention#Materials_specifications_-_filter_media) depth is 2.5 feet or more to allow adequate **filtration** (https://stormwater.pca.state.mn.us/index.php?title=Filtration) processes to occur. Most media mixes are suitable because phosphorus is not a significant concern with this practice. The Construction General Permit (https://stormwater.pca.state.mn.us/index.php?title=Construction_stormwater_program) requires that water captured by the BMP be drawn down within 48 hours. **Hydrologic soil group (https://stormwater.pca.state.mn.us/index.php?title=Design_infiltration_rates)** A and B soils are commonly suitable for bioinfiltration. Bioinfiltration is suitable for areas and land uses that are expected to generate nutrient runoff (e.g. residential and business campuses) that can be infiltrated and captured by the practice. Fresh mulch rather then aged shredded bark mulch can be used to enhance **denitrification** processes if nitrate leaching is a concern. Bioinfiltration is not recommended for **potential stormwater hotspots (https://stormwater.pca.state.mn.us/index.php?title=Potential_stormwater_hotspots)**. Other infiltration constraints apply to bioinfiltration practices.

A bioretention facility (rain garden) in a residential area. Note the curb cut that allows water to enter the facility.

Biofiltration with underdrain at bottom

This bioretention practice is designed with an underdrain at the **invert** of the planting soil mix to ensure drainage at a desired rate. The practice allows for partial recharge and an impervious liner is not used. The depth is also shallow (2.5 feet) to allow high capacity flows if necessary. Siting is suitable for visually prominent or gateway

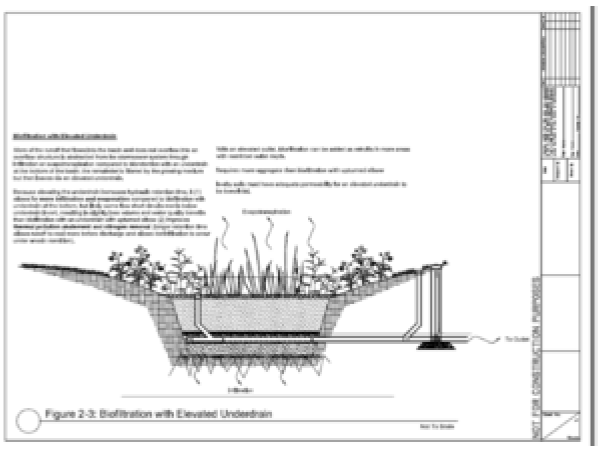
locations in a community. The practice is suitable for areas and land uses that are expected to generate metals loadings (e.g. residential, business campus, or parking lots). The practice is suitable for areas with high nutrient loadings provided the media has a low phosphorus concentration or phosphorus-sorbing amendments are used (see section on filter media). This type of facility is also recommended for soils where infiltration is limited (C and D soils). Some volume reduction will be seen from **evapotranspiration** and partial infiltration below the underdrain.



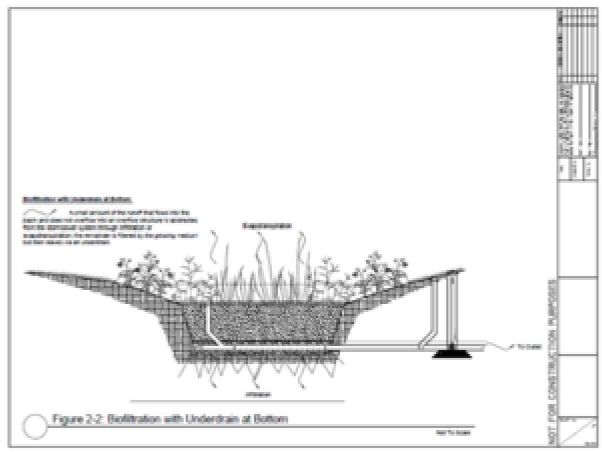
Bioinfiltration device

Biofiltration with elevated underdrain

A biofiltration practice with a raised underdrain provides a storage area below the invert of the underdrain discharge pipe. This area provides a recharge zone and quantity control can also be augmented with this storage area. The storage area is equal to the void space of the material used. Since the practice utilizes both infiltration and an underdrain, considerations include those for both bioinfiltration practices and biofiltration with an underdrain at the bottom. These include an assessment of infiltration constraints and media.



Biofiltration device with elevated underdrain



Biofiltration device with an underdrain at the bottom

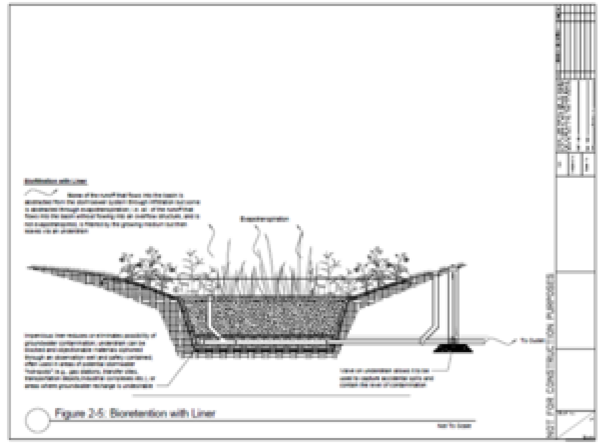
Biofiltration with a liner (at bottom and or on sides)

This type of facility is recommended for areas that are known as potential stormwater hot spots (e.g. gas stations, transfer sites, and transportation depots). An important feature of this type of facility is the impervious liner designed to reduce or eliminate the possibility of groundwater contamination. The facility provides a level of treatment strictly through filtration processes that occur when the runoff moves through the soil material to the underdrain discharge point. In the event of an accidental spill, the underdrain can be blocked and the objectionable materials siphoned through an observation well and safely contained.

Biofiltration with internal water storage

The biofiltration practice with internal water storage is not commonly used in the Midwestern United States but is widely used in some places on the east coast, such as North Carolina. The use of an upturned elbow in this practice allows water to be retained within the practice, leading to increased pollutant removal, increased infiltration, and increased evapotranspiration. The practice is particularly effective at removing nitrogen through denitrification.

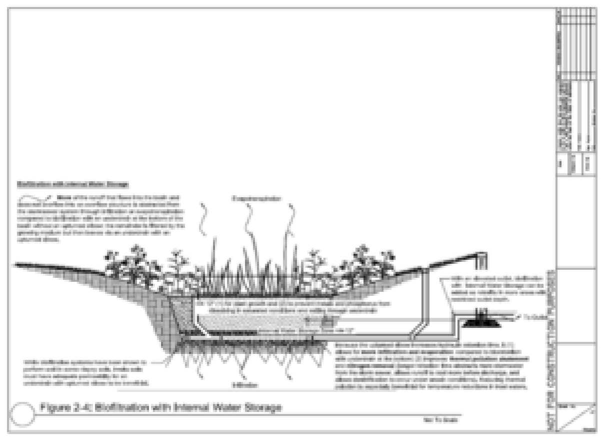
The media should be 3 feet or more thick to allow water to be drawn down below the root zone. Underlying soils should be permeable enough to allow water stored within the practice to infiltrate.



Biofiltration device with a liner

Design types for various land uses

It should be noted that the layout of the bioretention area will vary according to individual sites, and to specific site constraints such as underlying soils, existing vegetation, drainage, location of utilities, sight distances for traffic, and aesthetics. Designers are encouraged to be creative in determining how to integrate bioretention into their respective site designs. With this in mind, the following are presented as alternative options.



Biofiltration device with internal water storage

On-lot / rain garden

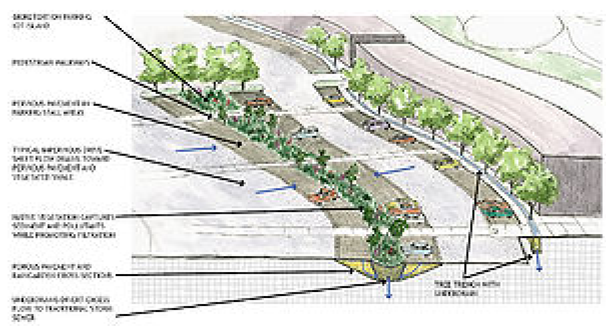
Simple design that incorporates a planting bed in the low portion of the site. On-lot systems are designed to receive flows from gutters, and/or other impervious surfaces.

Parking lot islands (curbless)

In a paved area with no curb, pre-cast car-stops or a “ribbon curb” can be installed along the pavement perimeter to protect the bioretention area. This application of bioretention should only be attempted where shallow grades allow for sheet flow conditions over level entrance areas. Water may be pooled into the parking area where parking spaces are rarely used to achieve an element of stormwater quantity control beyond the confines of the bioretention surface area (Prince George’s County, 2002).

Parking lot islands (curb-cut)

For curb-cut entrance approaches, the water is diverted into the bioretention area through the use of an inlet deflector block, which has ridges that channel the runoff into the bioretention area (Prince George’s County (https://www.slideshare.net/Sotirakou964/md-prince-georges-county-bioretention-manual), 2002). Special attention to erosion control and pre-treatment should be given to the concentrated flow produced by curbcuts.



A bioretention parking lot island. Note the use of other BMPs, including permeable pavement and tree trenches. (Source: Minnehaha Creek Watershed District (http://www.minnehahacreek.org/))

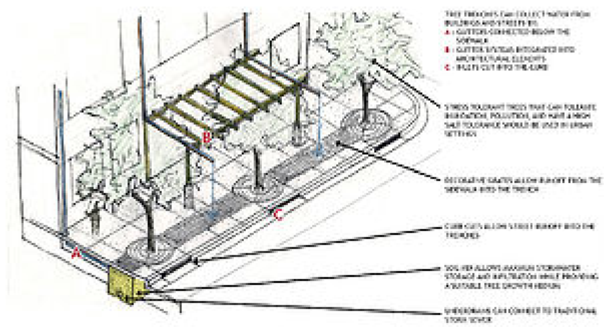
Road medians / traffic islands

A multifunctional landscape can be created by utilizing road medians and islands for bioretention. There is no minimum width recommended for traffic islands from street edge to

edge. A buffer may be necessary along the outside curb perimeter to minimize the possibility of drainage seeping under the pavement section, and creating "frost heave" during winter months. Alternately, the installation of a geotextile filter fabric "curtain wall" along the perimeter of the bioretention island will accomplish the same effect.

Tree pits / tree box filters

Tree pits and tree box filters afford many opportunities for bioretention. Designs vary widely from simple "tree pits", used for local drainage interception to more formal Tree Box Filters, which are a useful tool for highly urbanized streetscapes.



A tree box filter. Note the curb cuts. (Source: Minnehaha Creek Watershed District (http://www.minnehahacreek.org/))

The tree pit technique provides very shallow ponding storage areas in a "dished" mulch area around the tree or shrub. Typically, the mulched area extends to the dripline for the tree and is similar to conventional mulching practices, except that the mulch area is depressed at least 2 to 3 inches rather than mounded around the tree (Low Impact Design Center (http://www.lid-stormwater.net/), 2005).

Tree box filters are bioretention areas installed beneath trees that can be very effective at controlling runoff, especially when distributed throughout the site. Runoff is directed to the tree box, where it is cleaned by vegetation and soil before entering a catch basin. The runoff collected in the tree-boxes helps irrigate the trees. The system consists of a container filled with a soil mixture, a mulch layer, under-drain system and a shrub or tree. Stormwater runoff drains directly from impervious surfaces through a filter media. Treated water flows out of the system through an underdrain connected to a storm drainpipe/inlet or into the surrounding soil. Tree box filters can also be used to control runoff volumes/flows by adding storage volume beneath the filter box with an outlet control device.

Related pages

- Bioretention terminology
- Overview for bioretention
- Types of bioretention
- Design criteria for bioretention
- Construction specifications for bioretention
- Operation and maintenance of bioretention
- Cost-benefit considerations for bioretention
- Soil amendments to enhance phosphorus sorption
- Supporting material for bioretention
- External resources for bioretention
- References for bioretention
- Requirements, recommendations and information for using bioretention BMPs in the MIDS calculator